

NATURAL

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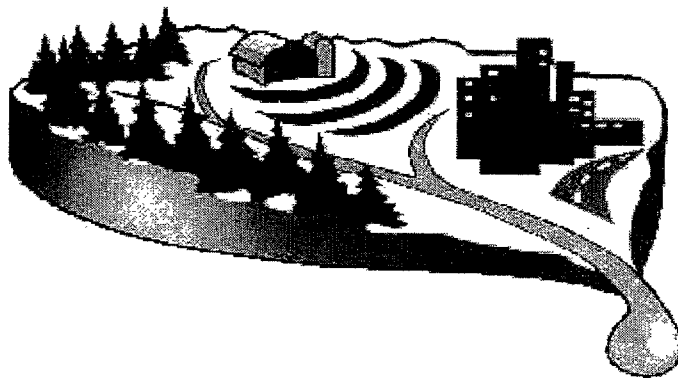
EPA-823-B-01-001  
June 2001



# Better Assessment Science Integrating point and Nonpoint Sources

## BASINS

Version 3.0



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User's Manual

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## **Disclaimer**

Production of this document has been funded wholly or in part by the U.S. Environmental Protection Agency. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Environmental Protection Agency. The Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) system described in this manual is applied at the user's own risk. Neither the U.S. Environmental Protection Agency nor the system authors can assume responsibility for system operation, output, interpretation, or use.

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## Acknowledgments

Version 3.0 of the Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) system builds on Version 2.0 of the system. See the Version 2.0 User's Manual for the team involved in the production of that version of the system.

Many groups contributed to the development of BASINS 3.0. Technical direction and guidance was provided by Russell Kinerson, Paul Cocca, Ed Partington, Marjorie Wellman and David Wells of EPA's Office of Science and Technology, Standards and Applied Science Division. Four groups outside of EPA made significant contributions to the BASINS 3.0 system.

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## User Assistance and Technical Support

BASINS was developed to promote better assessment and integration of point and nonpoint sources in watershed and water quality management. It integrates several key environmental data sets with improved analysis techniques. Several types of environmental programs can benefit from the use and application of such an integrated system in various stages of environmental management planning and decision making.

EPA's Office of Science and Technology (OST) provides assistance and technical support to users of the BASINS system to facilitate its effective application. Technical support can be obtained at OST's **BASINS Home Page:** <http://www.epa.gov/ost/basins>

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## Contents

1 Introduction.....	1
2 System Overview.....	5
2.1 Data Products .....	8
2.2 Environmental Assessment Tools .....	14
2.3 Utilities .....	16
2.4 Watershed Characterization Reports .....	18
2.5 Watershed and Instream Models .....	20
3 Hardware and Software Requirements .....	23
4 Installation.....	25
4.1 System Setup .....	27
4.2 Data Extraction.....	34
4.3 Project Builder.....	49
4.4 Opening a BASINS Project.....	52
5 Basins Components - Extension Manager .....	55
6 BASINS Assessment Tools .....	69
6.1 TARGET .....	70
6.2 ASSESS.....	77
6.3 Data Mining.....	84
7 Data Extensions .....	91
7.1 Theme Manager.....	92
7.2 Import BASINS Data .....	94
7.3 NHD Download Tool .....	103
7.4 Grid Projector .....	113
7.5 GenScn .....	133
7.6 WDMUtil .....	134
8 Delineation Tools.....	135
8.1 Manual Watershed Delineation.....	136
8.2 Automatic Watershed Delineation .....	158
8.2.1 DEM Setup .....	160
8.2.2 Stream Definition .....	178
8.2.3 Outlet and Inlet Definition.....	180
8.2.4 Main Watershed Outlet Selection and Definition.....	189
8.2.5 Reservoirs .....	194
8.3 Predefined Delineation .....	197
9 BASINS Utilities .....	205
9.1 Land Use, Soils Class and Overlay.....	206
9.1.1 Land Use and Soil Definition .....	206
9.1.2 HRUs Distribution .....	231
9.2 Land Use Reclassification.....	240

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9.3 Water Quality Observation Data Management .....	245
9.4 DEM Reclassification .....	257
10 Watershed Characterization Reports.....	263
10.1 Point Source Inventory Report.....	264
10.2 Water Quality Summary Report.....	271
10.3 Toxic Air Emission Report .....	277
10.4 Land Use Distribution Report .....	283
10.5 State Soil Characteristic Report .....	288
10.6 Watershed Topographic Report .....	296
10.7 Land Use Distribution Report (Grid) .....	302
10.8 Watershed Topographic Report (Grid) .....	313
10.9 Lookup Tables.....	321
11 Selecting Watershed and Instream Models.....	329
11.1 QUAL2E .....	332
11.2 HSPF .....	333
11.3 SWAT.....	334
11.4 PLOAD.....	335
12 References.....	337

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# 1 Introduction

Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) is a multipurpose environmental analysis system for use by regional, state, and local agencies in performing watershed- and water-quality-based studies. It was developed by the U.S. Environmental Protection Agency's (EPA's) Office of Water to address three objectives:

- To facilitate examination of environmental information
- To support analysis of environmental systems
- To provide a framework for examining management alternatives

Because many states and local agencies are moving toward a watershed-based approach, the BASINS system is configured to support environmental and ecological studies in a watershed context. The system is designed to be flexible. It can support analysis at a variety of scales using tools that range from simple to sophisticated.

BASINS was also conceived as a system for supporting the development of total maximum daily loads (TMDLs). Section 303(d) of the Clean Water Act requires states to develop TMDLs for water bodies that are not meeting applicable water quality standards by using technology-based controls. Developing TMDLs requires a watershed-based approach that integrates both point and nonpoint sources. BASINS can support this type of watershed-based point and nonpoint source analysis for a variety of pollutants. It also lets the user test different management options.

Traditional approaches to watershed-based assessments typically involve many separate steps preparing data, summarizing information, developing maps and tables, and applying and interpreting models. Each individual step is performed using a variety of tools and computer systems. The isolated implementation of steps can result in a lack of integration, limited coordination, and time-intensive execution. BASINS makes watershed and water quality studies easier by bringing key data and analytical components "under one roof". Using the familiar Windows environment, analysts can efficiently access national environmental information, apply assessment and planning tools, and run a variety of proven, robust nonpoint loading and water quality models. With many of the necessary components together in one system, the analysis time is significantly reduced, a greater variety of questions can be answered, and data and management needs can be more efficiently identified. BASINS takes advantage of recent developments in software, data management technologies, and computer capabilities to provide the user with a fully comprehensive watershed management tool.

A geographic information system (GIS) provides the integrating framework for BASINS. GIS organizes spatial information so it can be displayed as maps, tables, or graphics. GIS provides techniques for analyzing landscape information and displaying relationships. Through the use of GIS, BASINS has the flexibility to display and integrate a wide range of information (e.g., land use, point source discharges, water supply withdrawals) at a scale chosen by the user. For example, some users will need to examine data at a multistate scale to determine problem areas, compare watersheds, or investigate gaps in data. Others will want to work at a much smaller scale, perhaps investigating a particular river segment impaired by multiple point source discharges. This "zooming" capability of BASINS makes it a unique and powerful environmental analysis tool.

Some agencies might wish to perform analyses at a variety of scales, in a nested fashion, to meet several objectives at once. BASINS is designed to facilitate all of these scenarios because it incorporates tools that operate on both large and small watersheds. Adding locally developed, high-resolution data sources to existing data layers is an additional option that expands the local-scale evaluation capabilities.

BASINS comprises a suite of interrelated components for performing the various aspects of environmental analysis. The components include (1) nationally derived databases with *Data Extraction* tools and *Project Builders*; (2) assessment tools (*TARGET*, *ASSESS*, and *Data Mining*) that address large- and small-scale characterization needs; (3) utilities to facilitate organizing and evaluating data; (4) tools for *Watershed Delineation*; (5) utilities for classifying dams, land use, soils, and water quality observations; (6) Watershed Characterization Reports that facilitate compilation and output of information on selected watersheds; (7) an instream water quality model, *QUAL2E*; (8) two watershed loading and transport models, Hydrological Simulation Program - Fortran (HSPF) and Soil and Water Assessment Tool (SWAT); and (9) PLOAD, a simplified GIS based model that estimates nonpoint loads (NPS) of pollution on an annual average basis.

The assessment component, working under the GIS umbrella, allows users to quickly evaluate selected areas, organize information, and display results. The modeling component module allows users to examine the impacts of pollutant loadings from point and nonpoint sources. Working together, these modules support several specific aspects of watershed-based analysis by

- Identifying and prioritizing water-quality-limited waters.
- Supplying data characterizing point and nonpoint sources and evaluating their magnitudes and potential significance.
- Integrating point source and nonpoint source loadings and fate and transport processes.
- Evaluating and comparing the relative value of potential control strategies.
- Visualizing and communicating environmental conditions to the public through tables, graphs, and maps.

This user's guide provides information on the systems and procedures in BASINS Version 3.0. This version provides some significant enhancements and functions beyond those provided by the original release of BASINS, Version 1.0 and Version 2.0. The modification and enhancement of the program reflect the extensive comments and input provided by the user community regarding the initial version. The significant changes between BASINS Versions include the following:

#### BASINS 3.0

- Addition of grid data sets including USGS DEM elevations grids (1:250,000 scale).
- Additional flexibility for users to import their own data layers including elevation, landuse soils, streams and point sources themes in shapefile and/or grid file formats.
- New utility to perform automatic watershed delineations based on DEM data. The new watershed delineation tool is used to generate and define the watershed boundary, stream network, and point source discharge themes to be used for watershed modeling using *HSPF* or *SWAT*. The stream network can be generated based on the DEM or defined by an existing stream theme such as USEPA



Reach File, Version 1 or Reach File, Version 3. Point source locations can be selected from the permit compliance system theme or manually added. The tool also generates many of the watershed and stream characteristics needed for modeling including slopes, elevations, and stream widths and depths.

- A significantly enhanced manual delineation tool that provides users additional flexibility in editing shapes and attributes of manually delineated watersheds.
- A grid projector that extends the ArcView projection tool to also project grid data. This component requires Spatial Analyst.
- An NHD download tool that allows users to download NHD data layers from the USGS web site and import them directly into a BASINS project window using the correct projection.
- Incorporation of the Soil and Water Assessment Tool (SWAT) developed by the USDA Agriculture Research Service (ARS). SWAT is a physical based, watershed scale model that was developed to predict the impacts of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land uses and management conditions over long periods of time. SWAT2000 is the underlying model that is run from the BASINS ArcView interface. SWAT requires the Spatial Analyst extension.
- A new interface to the Hydrological Simulation Program - Fortran (HSPF), called *WinHSPF*. In earlier versions of BASINS, the interface to HSPF was known as the Nonpoint Source Model (NPSM). WinHSPF builds upon the successes of NPSM, but adds enhanced graphical displays and editing capabilities such that all features of HSPF are available in WinHSPF. WinHSPF fully supports the MASS-LINK, SCHEMATIC and SPECIAL ACTIONS blocks of the UCI File. This interface also directly reads HSPF UCI file.
- A postprocessor known as *GenScn*. GenScn works with data in a variety of formats including Watershed Data Management (WDM) files, SWAT output files, and BASINS observed water quality files.
- A utility program for managing WDM files known as *WDMUtil*. WDM files are used by HSPF for input and output timeseries data. WDMUtil was designed to help manage the large volumes of timeseries data used with HSPF, as well as to add additional timeseries where needed.
- A pollutant loading program known as *PLOAD*. Developed by CH2M-Hill, PLOAD estimates nonpoint sources of pollution on an annual average basis, for any user-specified pollutant, using either the export coefficient or simple method approach.

## BASINS 2.0

- Additions to the base data sets include USEPA Reach File Version 3 Alpha (RF3 Alpha), STATSGO soils, DEM elevation data, federal and Indian land boundaries, water quality observation data, ecoregions, fish and wildlife consumption advisories, shellfish contamination, and Clean Water Needs Survey.

- New utilities to facilitate data preparation such as *Watershed Delineation* and Watershed Characterization Reports.
- Expanded functionality of the nonpoint source modeling system to include in-stream transport and visualization.
- Postprocessing tools for evaluation of model output.

Users are encouraged to continue to provide EPA with comments and recommendations for further development. Future enhancements to the system might include adding additional types of information, using higher-resolution data, providing Internet access to data and model updates, expanding assessment and evaluation capabilities, providing enhanced data management and display tools, and adding a wider range of nonpoint source water quality and ecological modeling techniques.

## 2 System Overview

The BASINS system combines six components to provide the range of tools needed for performing watershed and water quality analyses. These interrelated components can be summarized as follows:

- National environmental databases
- Assessment tools
- Utilities
- Watershed characterization reports
- Water quality stream models
- Watershed Models and Postprocessors

A graphical representation of the BASINS components and their operating platform is provided as Figure 2.1.

The BASINS physiographic data, monitoring data, and associated assessment tools are integrated in a customized geographic information system (GIS) environment. The GIS used is ArcView 3.1 developed by Environmental Systems Research Institute, Inc. The simulation models are integrated into this GIS environment through a dynamic link in which the data required to build the input files are generated in the ArcView environment and then passed directly to the models. The models themselves run in either a Windows or a DOS environment. The results of the simulation models can also be displayed visually and can be used to perform further analysis and interpretation.

Although BASINS 3.0 remains ArcView-based, the BASINS system architecture has been completely reengineered for version 3.0. Unlike its predecessor, all customized components of BASINS 3.0, such as model interfaces, data management utilities, and watershed assessment tools, are developed as BASINS extensions, thereby providing users the capability to load only the extensions needed for their BASINS project. The new architecture also allows the system to support several levels of hardware and software sophistication. For example, users might not need to acquire Arcview's Spatial Analyst extension if they do not intend to use BASINS components that require Spatial Analyst. For the developers, it will be easier to maintain and provide updates of the individual extensions rather than issuing a new version of the entire system. This makes it also easier for the users to upgrade their system.

The modeling tools include the following:

In-stream models:

- *QUAL2E*, version 3.2, a water quality and eutrophication model.

## BASINS V3.0 System Overview

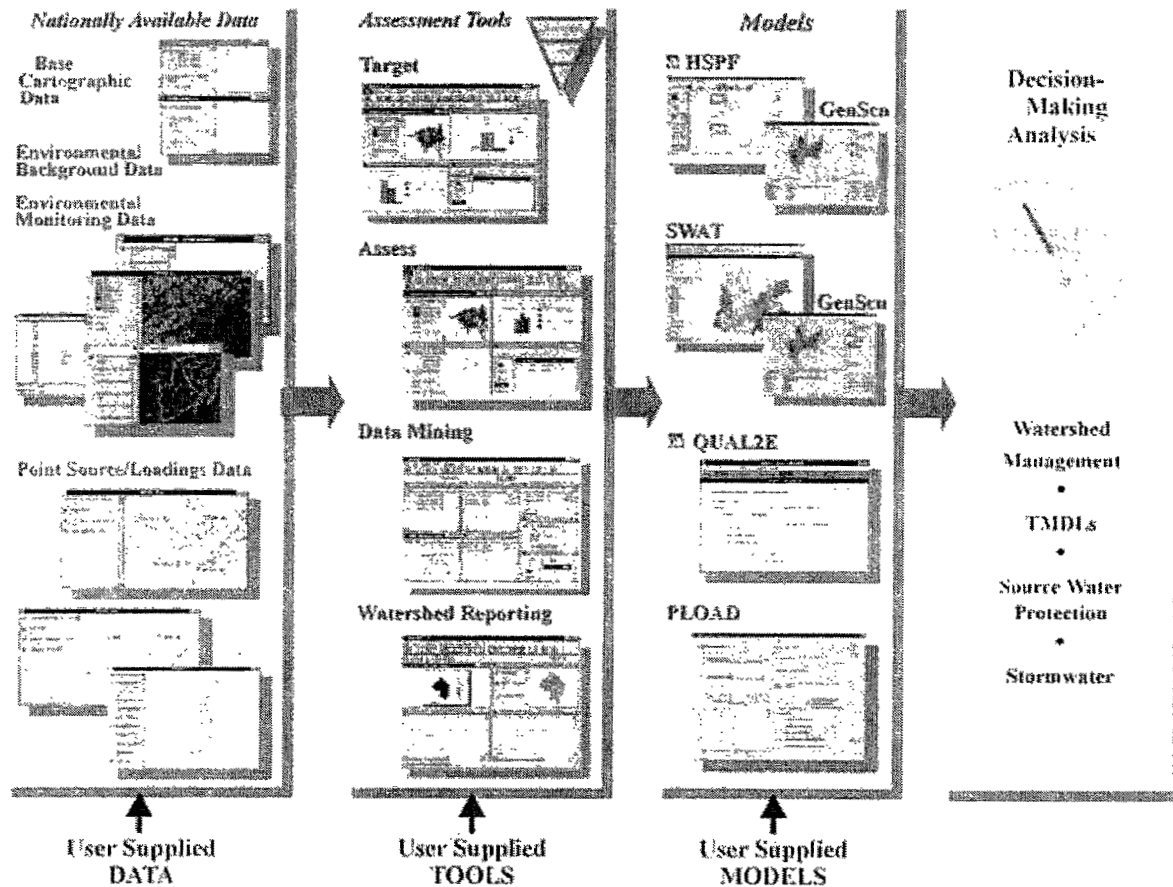


Figure 2.1 System Overview

### Watershed Models:

- *WinHSPF* is an interface to the Hydrological Simulation Program Fortran (HSPF), version 12. HSPF is a watershed scale model for estimating instream concentrations resulting from loadings from point and nonpoint sources.
- *SWAT* is a physical based, watershed scale model that was developed to predict the impacts of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land uses and management conditions over long periods of time. SWAT2000 is the underlying model that is run from the BASINS ArcView interface.

**Loading models:**

- *PLOAD*, a pollutant loading model. *PLOAD* estimates nonpoint sources of pollution on an annual average basis, for any user-specified pollutant, using either the export coefficient or simple method approach.

The BASINS GIS, which is driven by the ArcView 3.1 or 3.2 environment, provides built-in additional procedures for data query, spatial analysis, and map generation. These custom BASINS procedures allow a user to visualize, explore, query available data, and perform individualized and targeted watershed-based analyses. Some familiarity with ArcView is helpful in accessing and fully utilizing the capabilities of ArcView and the custom analytical tools. Furthermore, as users become familiar with ArcView's standard operations, environmental relationships can be further investigated using complex queries, overlays, proximity analyses, and buffer analyses.

## 2.1 Data Products

The BASINS system includes a variety of databases that are extracted and formatted to facilitate watershed-based analysis and modeling. The databases were compiled from a wide range of federal sources. The data were selected based on relevance to environmental analysis, national availability, and scale and resolution. As new data become available, updates may be distributed through the BASINS Internet site. Users are also encouraged to import locally derived data sets or higher-resolution coverages into BASINS to support the most appropriate and accurate analysis (see Section 7.2, Import). The data included within BASINS are intended to provide a starting point and data for those areas where limited site-specific information is available.

Four types of data are delivered with the BASINS analysis system:

- Base cartographic data
- Environmental background data
- Environmental monitoring data
- Point sources/loading data

### Base Cartographic Data

BASINS' base cartographic data include administrative boundaries, hydrologic boundaries, and major road systems. These data are essential for defining and locating study areas and defining watershed drainage areas. The base cartographic data products included in BASINS are presented in Table 2.1.1.

Table 2.1.1 **Base Cartographic Data**

Data Product	Source	Description
Hydrologic Unit Boundaries	U.S. Geological Survey (USGS)	Nationally consistent delineations of the hydrographic boundaries associated with major U.S. river basins
Major Roads <sup>2</sup>	Federal Highway Administration	Interstate and state highway network
Populated Place Locations <sup>2</sup>	USGS	Location and names of populated locations
Urbanized Areas <sup>2</sup>	Bureau of the Census	Delineations of major urbanized areas used in 1990 Census
State and County Boundaries	USGS	Administrative boundaries
EPA Regions	USGS	Administrative boundaries

### Environmental Background Data

Environmental background data provide information to support watershed characterization and environmental analyses. These data include information on soil characteristics, land use coverages, and the stream hydrography. This information is used in combination with modeling tools to perform more detailed assessment of watershed conditions and loading characteristics. Table 2.1.2 lists the environmental background data included in BASINS.

Table 2.1.2 Environmental Background Data

BASINS Data Product	Source	Description
Ecoregions Level III <sup>2</sup>	U.S. Environmental Protection Agency (USEPA)	Ecoregions and associated delineations
National Water Quality Assessment (NAWQA) Study Unit Boundaries <sup>2</sup>	USGS	Delineations of study areas
1996 Clean Water Needs Survey <sup>2</sup>	USEPA	Results of the wastewater control needs assessment by state
State Soil and Geographic (STATSGO) Database	U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS)	Soils information including soil component data and soils
Managed Area Database <sup>2</sup>	University of California, Santa Barbara	Data layer including federal and Indian lands
Reach File Version 1 (RF1)	USEPA	Provides stream network for major rivers and supports development of stream routing for modeling purposes (1:500k)
Reach File Version 3 (RF3) Alpha <sup>1</sup>	USEPA	Alpha version of Reach File 3; provides a detailed stream network and supports development of stream routing for modeling purposes (1:100K)
National Hydrography Dataset <sup>1</sup>	USGS	Spatial dataset based upon the USGS DLG and the USEPA RF3, that is more refined and expanded. Contains information about surface water features which are combined to form reaches (surface water drainage network), facilitating in routing for modeling purposes(1:100K)
Digital Elevation Model (DEM) <sup>1</sup>	USGS	Topographic relief mapping; supports watershed delineations and modeling



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(DEM) <sup>1</sup>		watershed delineations and modeling
Land Use and Land Cover <sup>1</sup>	USGS	Boundaries associated with land use classifications including Anderson Level 1 and Level 2
National Inventory of Dams <sup>2</sup>	U.S. Army Corps of Engineers and the Federal Emergency Management Agency	This dataset provides a locational map of 75,187 dams in the conterminous United States. This database shows the age/description of the dam, number of people living downstream, and some inspection information along with some locational information.

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### Environmental Monitoring Data

BASINS contains several environmental data products developed from existing national water quality databases. These databases were converted into locational data layers to facilitate the assessment of water quality conditions and the prioritization and targeting of water bodies and watersheds. These data can be used to assess the current status and historical trends of a given water body and also to evaluate the results of management actions. Table 2.1.3 lists the environmental monitoring data included in BASINS.

Table 2.1.3 BASINS Environmental Monitoring Data

BASINS Data Product	Source	Description
Water Quality Monitoring Stations and Data Summaries	USEPA	Statistical summaries of water quality monitoring for physical and chemical-related parameters; parameter-specific statistics computed by station for 5-year intervals from 1970 to 1994 and 3-year interval from 1995 to 1997
Bacteria Monitoring Stations and Data Summaries	USEPA	Statistical summaries of bacteria monitoring; parameter-specific statistics computed by station for 5-year intervals from 1970 to 1994 and 3-year interval from 1995 to 1997
Water Quality Stations and Observation Data	USEPA	Observation-level water quality monitoring data for selected locations and parameters
National Sediment Inventory (NSI) Stations and Database	USEPA	Sediment chemistry, tissue residue, and benthic abundance monitoring data for freshwater and coastal sediments
Listing of Fish and Wildlife Advisories	USEPA	State reporting of locations with advisories for fishing, including type of impairment
Gage Sites	USGS	Inventory of surface water gaging station data including 7Q10 low and monthly mean stream flow
Weather Station Sites	National Oceanic and Atmospheric Administration (NOAA)	Location of selected first-order NOAA weather stations
Drinking Water Supply (DWS) Sites <sup>2</sup>	USEPA	Location of public water supplies, their intakes, and sources of surface water supply
Watershed Data Stations and Database	NOAA	Location of selected meteorologic stations and associated monitoring information used to support modeling
Classified Shellfish Areas <sup>2</sup>	NOAA	Location and extent of shellfish closure areas

### Point Source/Loading Data

BASINS also includes information on pollutant loading from point source discharges. The location, type of facility, and estimated loading are provided. These loadings are also used to support evaluation of watershed-based loading summaries combining point and nonpoint sources. Potential source loading locations from hazardous waste sites and air emissions are also included. Table 2.1.4 lists the point source/loading data included in BASINS.

Table 2.1.4 BASINS Point Source/Loading Data

BASINS Data Product	Source	Description
Permit Compliance System (PCS) Sites and Computed Annual Loadings	USEPA	NPDES permit-holding facility information; contains parameter-specific loadings to surface waters computed using the EPA Effluent Decision Support System (EDSS) for 1990-1999
Industrial Facilities Discharge (IFD) Sites	USEPA	Facility information on industrial point source dischargers to surface waters
Toxic Release Inventory (TRI) Sites and Pollutant Release Data	USEPA	Facility information for 1987-1995 TRI public data; contains Y/N flags for each facility indicating media-specific reported releases
Superfund National Priority List Site <sup>2</sup>	USEPA	Location of Superfund National Priority List sites from CERCLIS (Comprehensive Environmental Response, Compensation and Liability Information System)
Resource Conservation and Recovery Information System (RCRIS) Sites <sup>2</sup>	USEPA	Location of transfer, storage, and disposal facilities for solid and hazardous waste
Minerals Availability System/Mineral Industry Location System (MAS/MILS) <sup>2</sup>	U.S. Bureau of Mines	Location and characteristics of mining sites

<sup>1</sup>Data Layers that are added into the BASINS project using the Add Theme Tool.

<sup>2</sup>Data Layers that are added into the BASINS project using the Theme Manager Extension.

## 2.2 Environmental Assessment Tools

Three geographically based analytical tools were developed in the BASINS GIS environment to perform both regional and site-specific analyses --*TARGET*, *ASSESS*, and *Data Mining*. *TARGET* permits a broad-based analysis; *ASSESS* is a simple assessment tool that operates on a single watershed or a limited number of watersheds; and *Data Mining* lets BASINS users more fully access the water quality and point source databases. The three geographically based analytical tools are fully developed to operate on the water quality and point source data layers, as described in Section 2.3. BASINS operates on hydrologic units or watersheds as defined by the United States Geological Survey delineations referred to as "cataloging units." These watersheds can vary in size from 10 square miles to several hundred square miles.

### TARGET

*TARGET* allows environmental managers to make a broad-based evaluation of a watershed's water quality and/or point source loadings. This watershed targeting tool is designed to perform analysis on the entire area extracted (e.g., EPA regions, state) and is best suited for project areas that include more than one watershed (cataloging unit). *TARGET* is designed to integrate and process a large amount of detailed, site-specific data associated with a particular region and to summarize the results on a watershed basis. Using these water quality or point source loading summaries, watersheds are then ranked based on the level of selected evaluation parameters (e.g., DO, BOD, zinc). This analysis allows users to draw preliminary conclusions on the wide range of environmental data included in BASINS (e.g., 50 water quality parameters and most of the parameters associated with point source dischargers).

### ASSESS

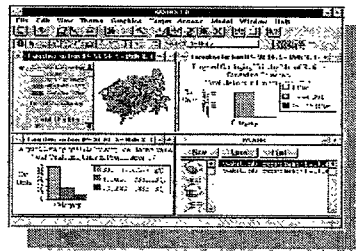
The second geographically based tool uses the same data as *TARGET* but provides a different perspective on the locational distribution of potential pollution problems. *ASSESS* operates on a single watershed (cataloging unit) or a limited set of watersheds and focuses on the status of specific water quality stations or discharge facilities and their proximity to water bodies. This proximity analysis (stream reaches, water quality stations, point dischargers, land uses, etc.) is important because it allows analysts to establish the interrelationships between the condition of a water body in a watershed and potential pollution sources. The level of detail provided by *ASSESS* lets users visually focus on the status of specific stream reaches, assess their changes over time, evaluate data availability, and evaluate the need for source characterization and analysis of cause-effect relationships.

### Data Mining

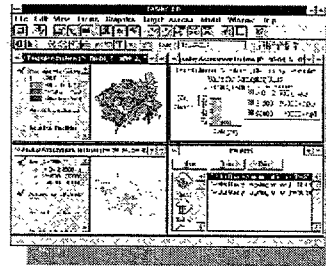
*Data Mining* dynamically links different data elements using a combination of tables and maps. This unique dynamic linkage of data elements adds a significant informational value to the raw data on water quality and loadings. This process makes *Data Mining* a powerful tool that can assist in the integration and environmental interpretation of both geographic and historical information simultaneously. *Data Mining* complements both *TARGET* and *ASSESS* by letting users move progressively from a regional analysis (provided by *TARGET*) to a watershed-scale analysis (provided by *ASSESS*) to a more detailed analysis at the station level (provided by *Data Mining*). This logical progression of the analysis from regional to site-specific is illustrated in Figure 2.2.

## Assessment Tools

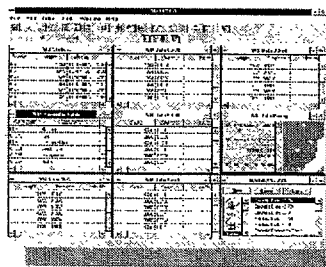
## Target



## Assess



# Data Mining



## Watershed Reporting

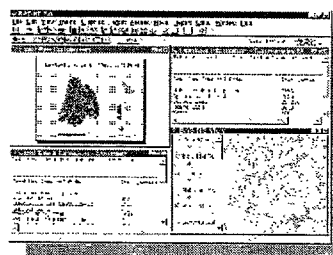


Figure 2.2

## 2.3 Utilities

### Theme Manager

The BASINS *Theme Manager* allows users to easily add or delete auxiliary data from a BASINS project. For BASINS 3.0, the BASINS databases were split into two groups of data, core data and auxiliary data. Auxiliary data are not directly used by any of the BASINS components.

### BASINS Import Tool

The BASINS *Import* tool gives the user the ability to import additional data sets and prepares the data to work properly with BASINS GIS functions and models. The *Import* tool is designed to function on five data types watershed boundaries, land use (shape and grid), Reach File Version 3, National Hydrography Dataset (NHD) and Digital Elevation Model (DEM) (shape and grid) format. This tool also provides the capability for users to import locally developed data, which might be more accurate, at a higher resolution, or more reflective of current conditions.

### NHD Download Tool

The *NHD Download* tool gives the user the ability to download a National Hydrographic Dataset (NHD) reach file directly from the USGS NHD ftp site and import the NHD reach file theme in the BASINS project using correct projection, preparing the data to work properly with BASINS GIS functions and models.

### Grid Projector

Grid Projector is a tool for conversion of ArcView/ArcInfo grid data between two map projections in ArcView environment. Grid Projector has capability for forward and inverse projection to and from a geographic reference (latitude-longitude) to several cartesian coordinates (feet, meters, etc.,).

### GenScn

GenScn facilitates the display and interpretation of output data derived from model applications. GenScn is not a model itself. It serves as a postprocessor for both the HSPF and SWAT models, as well as a tool for visualizing observed water quality data and other timeseries data.

### WDMUtil

WDMUtil is a utility program for managing Watershed Data Management (WDM) files, which contain input and output timeseries data for HSPF.

### Manual Delineation Tool

The BASINS *Manual Watershed Delineation* tool allows the user to delineate subwatersheds manually. It allows the user to subdivide a watershed into several smaller hydrologically connected watersheds based on the user's knowledge of that watershed's drainage topography. The tool also provides users the flexibility to edit shapes and attributes of manually delineated watersheds, outlets and generating stream networks.

### **Automatic Delineation Tool**

The BASINS *Automatic Watershed Delineation* tool allows the user to delineate subwatersheds based on an automatic procedure using Digital Elevation Model (DEM) data. User specified parameters provide limits that influence the size and number of subwatersheds created. This option requires the ESRI Spatial Analysis extension.

### **Predefined Delineation Tool**

The Predefined Delineation Tool is used to import existing subwatershed boundaries, streams, and outlets themes into the current BASINS project, for the purposes of watershed characterization and modeling.

### **Land Use, Soil Classification, and Overlay**

The Land Use, Soil Classification, and Overlay Tool allows the user to load land use and soil themes into the current project and determine the land use soil class combinations and distributions for the delineated watershed(s) and each respective sub-watershed. One or more unique land use/soil combinations (hydrologic response units or HRUs) can be created for each subbasin.

### **Land Use Reclassification**

The *Land Use Reclassification* tool assists the user in grouping or renaming land use categories as needed to support modeling and analysis. Land uses can be reclassified in one of two ways: reclassification of the entire theme (all land uses) or reclassification of selected themes (single or multiple land uses from within an entire theme).

### **Water Quality Observation Data Management**

The *Water Quality Observation Data Management* utilities can be used to access and manipulate the water quality observation data within the BASINS system. They can also be used to add new stations to the data, delete unnecessary stations, relocate misplaced stations, and incorporate new water quality observation time-series data.

### **DEM Reclassification**

*DEM Reclassification* performs topographic reclassification on a watershed. It allows users to define a level of detail for reclassification of Digital Elevation Model (DEM). It permits nonuniform reclassification to capture and display the key topographic features of the watershed. By assigning different classification intervals for the hilltop zone and valley zone, users can create suitable topographic classifications to describe the relief of the watershed they are evaluating.

### **Lookup Tables**

The *Lookup Tables* provide users quick access to relevant reference information on data products included within BASINS. Information is provided for products such as the map projection, definition of agency codes for monitoring data, Standard Industrial Classification (SIC) codes, and the water quality criteria and threshold values of selected pollutants.

## 2.4 Watershed Characterization Reports

The Watershed Characterization Reporting tools are designed to assist users in summarizing key watershed information in the form of standard and automated reports. These tools can be used to make an inventory and characterize both point and nonpoint sources at various watershed scales. The results are presented in table, chart and/or map layout formats. These reports allow users to quickly evaluate and define data availability for the selected watershed(s). Eight different types of watershed characterization reports are included in BASINS:

- Point Source Inventory Report
- Water Quality Summary Report
- Toxic Air Emission Report
- Land Use Distribution Report
- Land Use Distribution Report(Grid)
- State Soil Characteristics Report
- Watershed Topographic Report
- Watershed Topographic Report(Grid)

### Point Source Inventory Report

*Point Source Inventory Report* provides a summary of discharge facilities in a given watershed. The report relies on the EPA Permit Compliance System (PCS) database to identify permitted facilities in a selected study area and summarizes their discharge loading for a given pollutant. Application of this report tool provides rapid identification of permitted sources, the receiving water body segment (Reach File Versions 1 or 3), and a mapping function to display the geographical distribution of point sources in the study area.

### Water Quality Summary Report

*Water Quality Summary Report* provides a summary of water quality monitoring stations within the selected watershed that monitored a particular pollutant during a given time period. The water quality data are presented as statistical summaries of the mean and selected percentiles of the observed data. The data is based on USEPA's Storage and Retrieval System (STORET). The information generated in this report can be summarized in tables and maps.

### Toxic Air Emission Report

*Toxic Air Emission Report* provides a summary of facilities within the selected watershed(s) with air releases of selected pollutants. This data is based on USEPA's Toxics Release Inventory (TRI). Tabular summaries of TRI facilities are generated with their corresponding estimates of pollutant air releases and other pertinent information such as facility identification name, city location, status (active or inactive



facility), ownership type (government, commercial), and SIC code number. This report also generates a map showing the location of the TRI facilities overlaid with the Reach File network (RF1 or RF3) and the boundary of the selected watershed.

### **Land Use Distribution Report**

*Land Use Distribution Report* provides a summary of the land use distribution within the selected watershed(s). The BASINS default land use data is based on the USGS Geographic Information Retrieval and Analysis System (GIRAS) and use the Anderson Level II classification system.

### **Land Use Distribution Report (Grid)**

BASINS 3.0 allows the use of Grid based themes to generate a Land Use Distribution Report. This option needs the ArcView Spatial Analyst extension. The new Multi Resolution Land Cover (MRLC) data (grid format) can be used.

### **State Soil Characteristic Report**

*State Soil Characteristic Report* provides a summary of the spatial variability of selected soil parameters within the selected watershed(s). The soil parameters considered include water table depth, bedrock depth, soil erodibility, available water capacity, permeability, bulk density, pH, organic matter content, soil liquid limit, soil plasticity, percent clay content, and percent silt and clay content. The data is based on the USDA-NRCS State Soil and Geographic Database (STATSGO).

### **Watershed Topographic Report**

*Watershed Topographic Report* provides a statistical summary and distribution of discrete land surface elevations in the watershed. It also generates an elevation map of the selected watershed. This information can be used to quickly evaluate the relative “steepness” of the watershed compared to that of other watersheds and correlate it with the results of water quality modeling. The data is based on DEM (shape format) distributed with BASINS.

### **Land Use Distribution Report (Grid)**

BASINS 3.0 allows the used of Grid based themes to generate a Watershed Topographic Report. This option needs the ArcView Spatial Analyst extension. The DEM (grid format) which can be downloaded from the USGS ftp site and can be used to generate the report. The information generated in this report is summarized in table, chart and map layout formats.

---

**Tip:** All reports that are created are stored under “Reports” GUI in the BASINS project. Use the *Show Report* submenu under the *Reports* menu to selectively view generated reports. This feature allows the user to view generated reports while in BASINS “View” without having to switch to the “Reports” section of the BASINS project. Note the *Show Report* submenu is part of the “Reports without Spatial Analyst” extension.

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## 2.5 Watershed and Instream Models

Three models are integrated into BASINS to allow the user to simulate the in-stream behavior of toxic chemicals, conventional pollutants, and nutrients. The models included were selected to allow users to assess in-stream water impacts at various levels of complexity. Data preparation, selection routines, and output display tools (for visualization) streamline the use of the models.

### QUAL2E

The *QUAL2E* model is provided to allow analysis of pollutant fate and transport through selected stream systems. It is a one-dimensional water quality model that assumes steady-state flow but allows simulation of diurnal (day-night) variations in temperature, algal photosynthesis, and respiration (Brown and Barnwell, 1987). The algorithms used in *QUAL2E* are based on the advection-dispersion mass transport equation solved using an implicit, backward difference scheme, averaged over time and space. *QUAL2E* represents the stream system as a series of computational elements of constant length. The model is integrated with BASINS through a Windows-based interface, and it allows fate and transport modeling of both point and nonpoint source loadings.

### HSPF

*HSPF* is a watershed model that simulates nonpoint source runoff and pollutant loadings for a watershed and performs flow and water quality routing in reaches. The Windows interface to HSPF, known as *WinHSPF*, works with the EPA-supported HSPF model (version 12.0) (Bicknell et al., 2000). *WinHSPF* supports a full suite of the HSPF model capabilities. Features supported by *WinHSPF* include:

- Estimation of nonpoint source loadings from mixed land uses
- Estimation of fate and transport processes in streams and one-dimensional lakes

*WinHSPF* can be run on a single watershed or a system of multiple hydrologically connected subwatersheds that have been delineated using the BASINS *Watershed Delineation* tool. The model requires land use data, reach data, meteorological data, and information on the pollutants of concern in the watershed and the reaches. *WinHSPF* is designed to interact with the BASINS utilities and data sets to facilitate the extraction of appropriate information and the preparation of model input files. The reach network is automatically developed based on the subwatershed delineations. Users can modify and adapt input files to site-specific conditions through the use of *WinHSPF* and supporting information provided by the BASINS utilities and reporting functions, as well as locally derived data sources. *WinHSPF* works with postprocessing tools to facilitate display and interpretation of output data.

### SWAT

The Soil and Water Assessment Tool (SWAT) is a physical based, watershed scale model that was developed to predict the impacts of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land uses and management conditions over long periods of time. SWAT was developed by the USDA Agriculture Research Service (ARS).

## **PLOAD**

PLOAD is an ArcView extension developed by CH2M HILL for calculating pollutant loads for watersheds. The application estimates nonpoint sources of pollution on an annual average basis, for any user-specified pollutant, using either the export coefficient or simple method approach. PLOAD was designed to be generic so that it can be applied as a screening tool in typical NPDES stormwater permitting, watershed management, or reservoir protection projects.

## **GenScn Postprocessor**

BASINS includes the program *GenScn*, originally developed by the U.S. Geological Survey, which facilitates the display and interpretation of output data derived from model applications. This tool allows users to select display locations and time periods. Displays are in graphical and tabular form. *GenScn* displays a variety of data formats, including *HSPF* simulation output, BASINS water quality observation data, and USGS flow data, and SWAT output data. It also performs statistical functions and data comparisons. Due to its ability to display and compare observed and modeled data, the postprocessor is a useful tool in model calibration and environmental systems analysis.

## 6 BASINS Assessment Tools

Three main geographically based tools *TARGET*, *ASSESS*, and *Data Mining* were developed to assess in-stream water quality conditions and point source discharges at the regional, watershed, and stream segment levels. These tools and their applications are described in this section. They are designed to work jointly to allow the user to perform regional assessments, identify hot spots at a watershed scale, define water quality and point source discharge conditions within watershed boundaries, and access and review summary data at a site-specific scale. In addition, using overlays of various BASINS data in conjunction with these assessment tools provides a powerful approach to establish preliminary relationships between in-stream water quality conditions and potential sources and causes.

---

<i>TARGET</i>	Performs a broad-based assessment on the entire extracted project area (region or state)
<i>ASSESS</i>	Used to assess data on an individual watershed (cataloging unit) or a limited set of watersheds.
<i>Data Mining</i>	Generates dynamic links between tables and maps for individual water quality stations or permitted facility discharges. In addition, <i>Data Mining</i> also operates on the bacteria monitoring station data layer.

---

## 6.1 TARGET

### *Purpose*

**TARGET** is used to perform broad-based water quality and/or point source loading data evaluations on the entire extracted project area.

### *Application*

The BASINS *TARGET* tool allows the user to make a broad-based evaluation of watershed conditions using water quality and/or point source loadings data included in the BASINS system. *TARGET* is designed to perform analysis on the entire project area extracted (e.g., EPA Region, state) and is best suited for project areas that include more than one watershed (cataloging unit). It is designed to integrate and process a large amount of detailed, site-specific data associated with a project area and to summarize the results on a watershed basis. Using water quality or loading summaries, *TARGET* ranks watersheds based on the evaluation parameters and thresholds selected by the user. This analysis can be used to draw preliminary conclusions based on the wide range of environmental data included in BASINS (e.g., 47 water quality parameters and most of the parameters associated with point source dischargers). The available data are analyzed for each watershed by computing a mean value for the selected parameter. These computed values are then used for comparisons between watersheds.

### **Before you Get Started**

First, verify that the “Target, Assess, and Data Mining” extension is active in your BASINS project by typing Ctrl+B from the BASINS view and selecting the **Assess** item from the **Extension Categories** dropdown list. The “Target, Assess, and Data Mining” entry in the **Basins Extensions** list should be visible and selected. If the “Target, Assess, and Data Mining” is not selected (checked), click on it to select it.

### *Key Procedures*

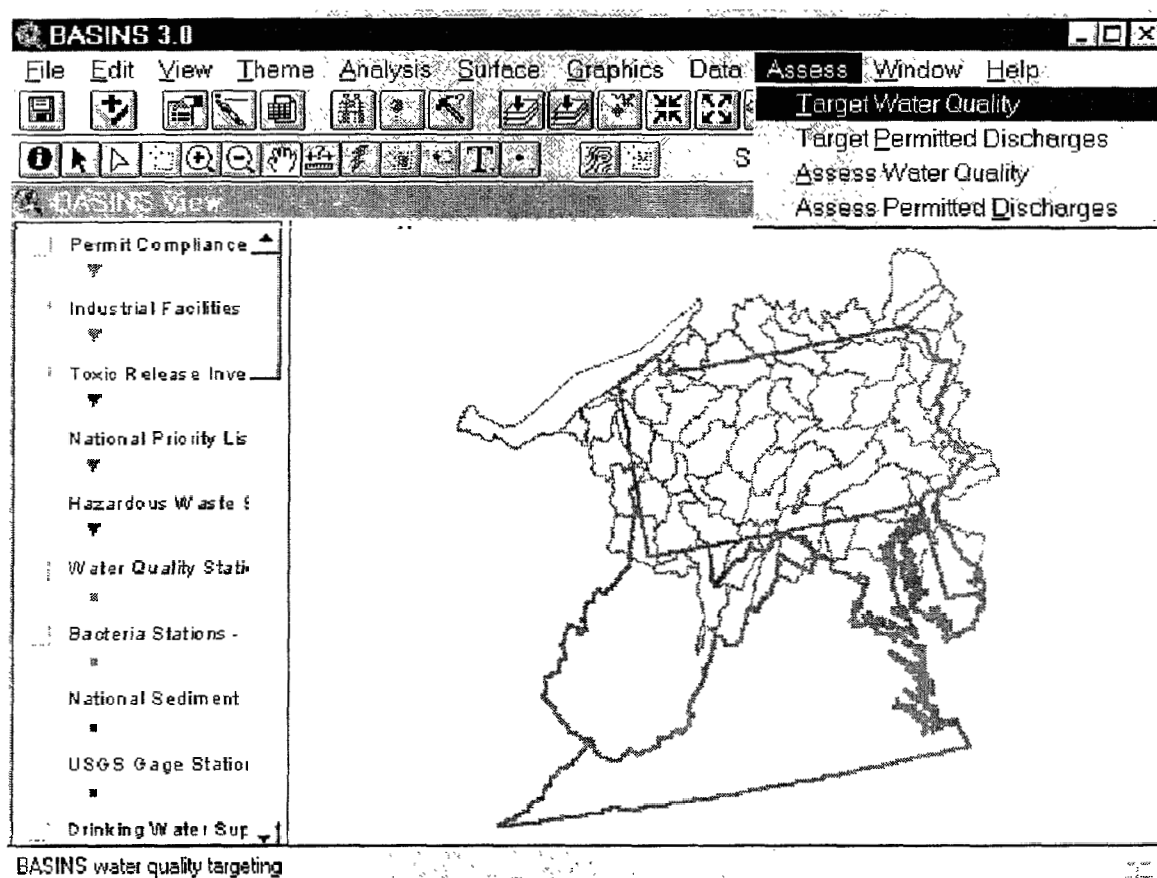
- Select “Target Water Quality” or “Target Permitted Discharges” from the *Assess* pull-down menu
- Select monitoring time period
- Select monitoring parameter to be evaluated
- Select desired statistical summary
- Enter threshold value (criterion)

### *Detailed Operations*

1. With BASINS View active, click the *Assess* menu and select either “Target Water Quality” or “Target Permitted Discharges” (Screen 6.1.1).

The remaining *TARGET* steps and associated screen captures are similar for both Water Quality and Permitted Discharges. The following examples correspond to a *TARGET* session using the Water Quality option.

**Tip:** *TARGET* automatically performs the analysis for the entire extracted project area. There is no need to select an area for analysis.



Screen 6.1.1

2. Select a monitoring period for *TARGET* to use for this session (Screen 6.1.2). Statistical summaries of monitoring data for each water quality station or permitted facility are provided for six time periods spanning 1974 to 1997. The statistical summaries are for station data spanning a 5-year period (3-year period for 1995-1997). Descriptive statistics (mean; 15th, 25th, 50th, 75th, and 85th percentiles) are provided for 47 physical and chemical-related parameters at each water

quality monitoring station. Refer to Appendix A for additional information on water quality monitoring and permitted discharge data included in BASINS.

A screenshot of a software dialog box titled "Water Quality Targeting". It contains a label "Select monitoring period:" followed by a dropdown menu currently showing "From 1995 to 1997". To the right of the dropdown are two buttons: "OK" and "Cancel".

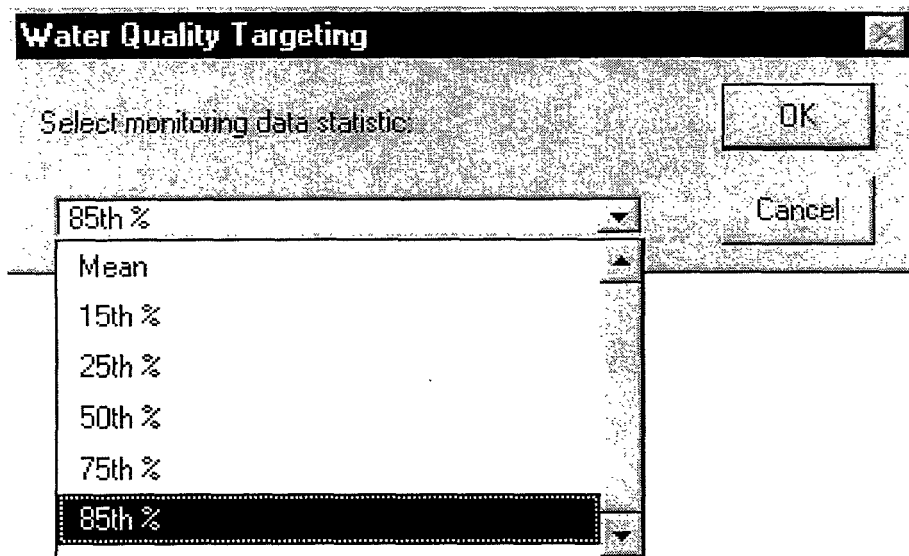
Screen 6.1.2

3. Select a parameter to evaluate (Screen 6.1.3).

A screenshot of the same "Water Quality Targeting" dialog box. The label now reads "Select monitoring parameter to evaluate:". The dropdown menu is open, displaying a list of parameters: "NITRATE NITROGEN, TOTAL", "LEAD, DISSOLVED", "MERCURY, TOTAL", "NICKEL, DISSOLVED", "NITRATE NITROGEN, TOTAL" (highlighted), "NITRITE PLUS NITRATE, DISS. 1 DET.", and "NITRITE PLUS NITRATE, TOTAL 1 DET.". The "OK" and "Cancel" buttons remain on the right.

Screen 6.1.3

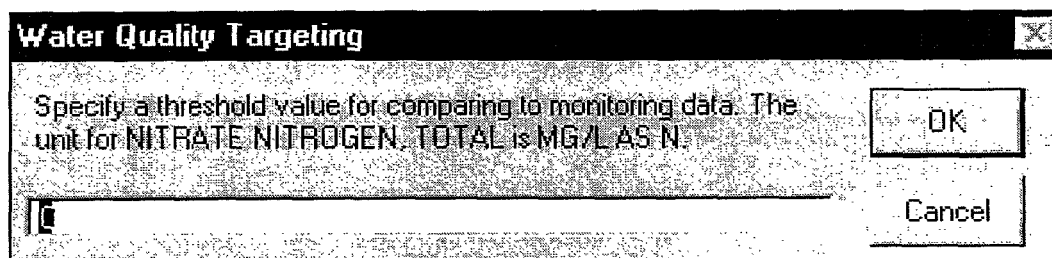
4. Select the desired summary statistics to be used for *TARGET* analysis (Screen 6.1.4).



Screen 6.1.4

5. Specify a threshold value for the selected monitoring parameter (Screen 6.1.5). The threshold value can be a regulatory water quality standard, a discharge standard, or a project-specific value. The default value is zero. As described below, the threshold value will be used to summarize the number of times the value is exceeded based on the monitoring data statistical summaries.

**Tip:** Water quality criteria for selected parameters are available in BASINS under the Water Quality Criteria Lookup Table, which can be activated under the Lookup menu. Refer to Section 7.6 for details on how to use lookup tables.



Screen 6.1.5

6. The *TARGET* session ends by generating three output windows (Screen 6.1.6) that summarize the results in map and graphical form:



- A map displaying the average monitoring value computed for each watershed (hydrologic cataloging unit) based on the user-specified parameter, statistical summary, and threshold value.
- A bar chart that shows the distribution of cataloging units with respect to the number of stations exceeding the selected threshold value.
- A bar chart that summarizes the distribution of cataloging units with respect to the average monitoring values.

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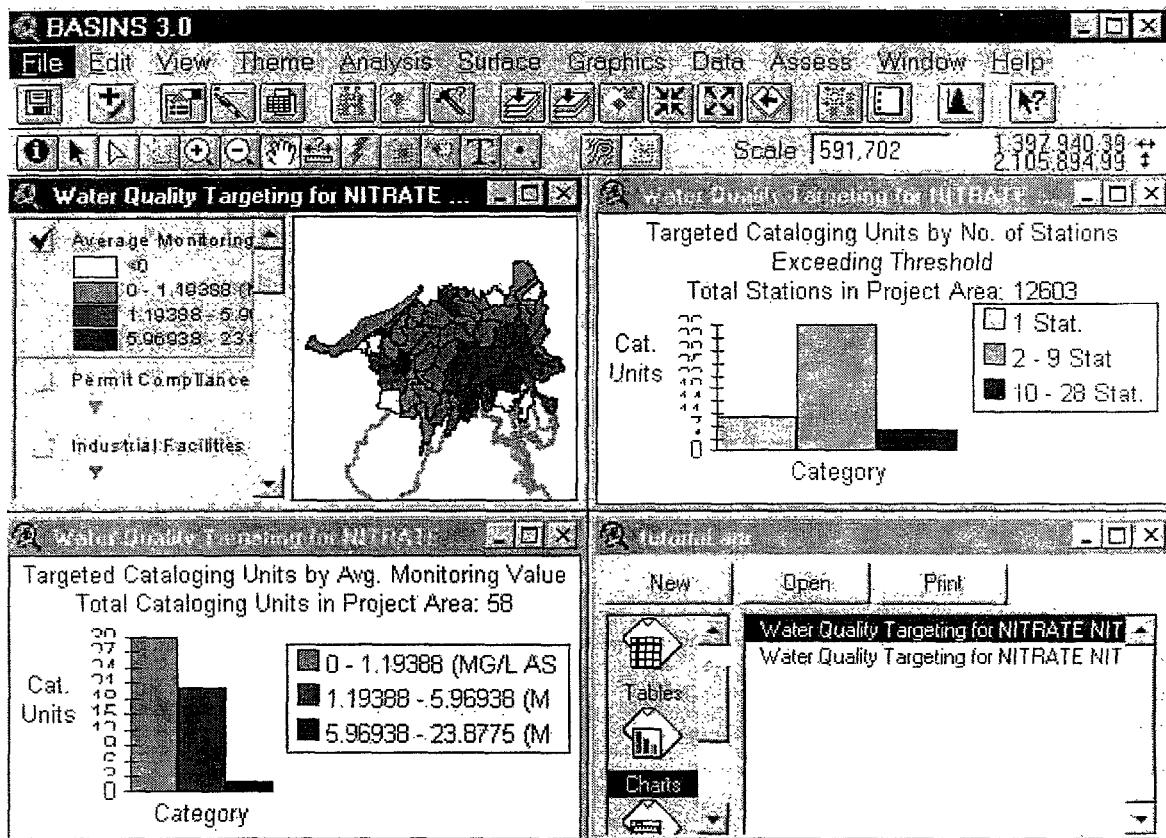
Tip: You can repeat this analysis using different monitoring time periods, parameters, and threshold values. You can also apply *TARGET* to the evaluation of point source information, using the same steps.

---

---

Tip: *TARGET* will notify you if no data are available for the selected parameter or if there are no data exceeding the selected threshold value.

---



Screen 6.1.6

**TUTORIAL:**

Select "Target Water Quality" from the *Assess* pull-down menu (Screen 6.1.1).

Select the following values for the given parameters:

- Monitoring period = 1995 to 1997 (Screen 6.1.2)
- Water quality monitoring parameter = "Nitrate Nitrogen, Total" (Screen 6.1.3)
- Statistical Summary = 85th percentile (Screen 6.1.4)
- Threshold value = 0 (Screen 6.1.5)

---

This *TARGET* session will generate a view showing the 85th percentile statistical summary of nitrate data collected between 1995 and 1997 for each watershed in the study area. Because a threshold value of zero was selected, all available data will be shown on the view. Watersheds that do not have data for the selected parameter are illustrated by the "< 0" classification in the legend. Screen 6.1.6 shows the output for this *TARGET* session. (Note: If a threshold value is selected, only watersheds with summary data values greater than the threshold value will be displayed. All other watersheds will be grouped into the "< threshold value" classification.)

---

## 6.2 ASSESS

### *Purpose*

The BASINS *ASSESS* tool allows users to perform water quality and point source discharge assessment on an individual watershed or a group of watersheds. The water quality assessment relies on the water quality statistical summaries database. It evaluates each monitoring station separately and provides a comparative view of the water quality condition at each station. The point source discharge assessment uses the Permit Compliance System (PCS) stations and corresponding data to produce a comparative view of sources based on the magnitude of their loading discharges.

### *Application*

*ASSESS* is the second geographically based analytical tool developed in the BASINS GIS environment. It is a simple assessment tool that allows the user to evaluate water quality and point source loading data for individual stations or facilities within a given watershed (cataloging unit) or group of watersheds. Following a *TARGET* analysis performed on a regional or state level, the user can apply *ASSESS* to examine in more detail those watersheds identified as areas of concern. Because it operates on individual stations (or point sources), it has several applications, including the following: evaluation of stream conditions, establishment of preliminary relationships between in-stream water quality conditions and potential sources and causes, and evaluation of monitoring programs and availability of monitoring data for selected water quality parameters.

### **Before you Get Started**

First, verify that the “Target, Assess, and Data Mining” extension is active in your BASINS project by typing Ctrl+B from the BASINS view and selecting the **Assess** item from the **Extension Categories** dropdown list. The “Target, Assess, and Data Mining” entry in the **Basins Extensions** list should be visible and selected. If the “Target, Assess, and Data Mining” is not selected (checked), click on it to select it.

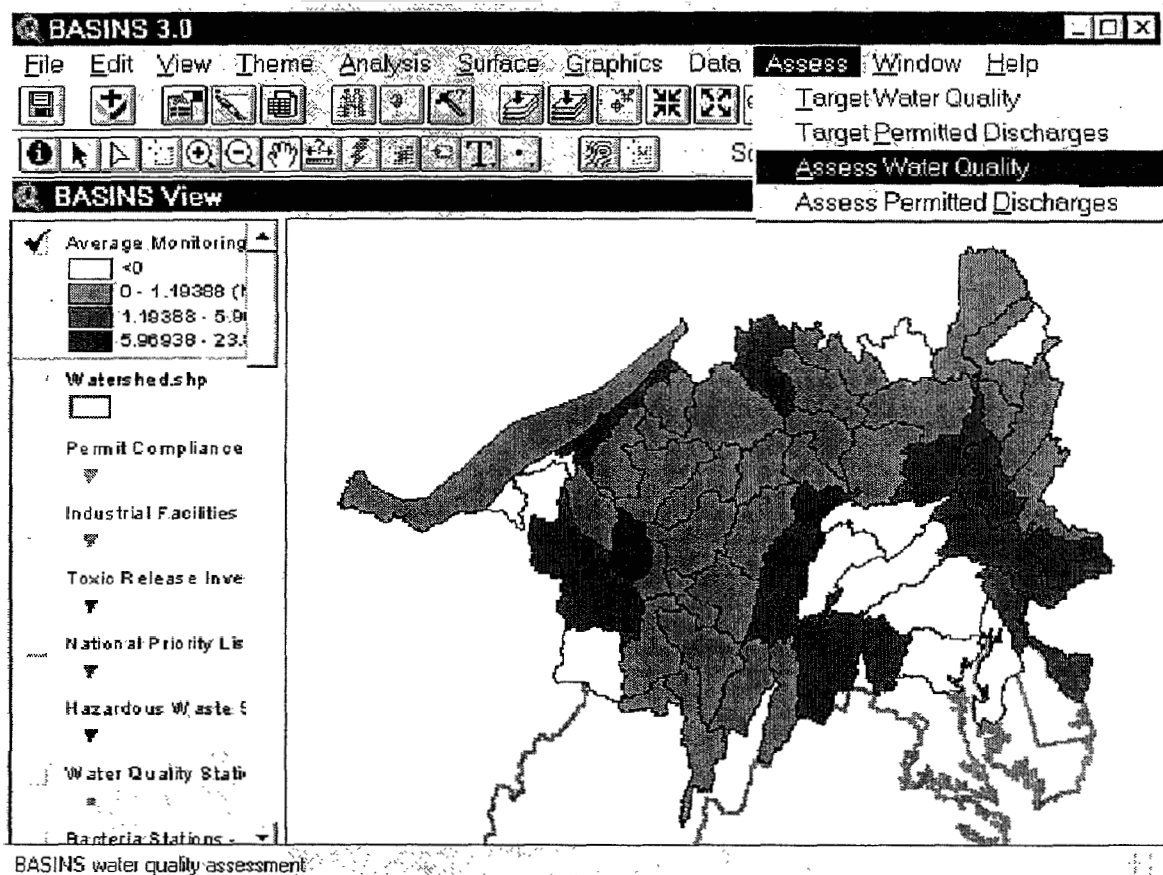
### *Key Procedures*

- Activate Cataloging Unit theme
- Select watershed(s)
- Select Water Quality or Permitted Discharges from the *ASSESS* pull-down menu.
- Select monitoring time period
- Select monitoring parameter to be evaluated
- Select desired statistical summary on which the analysis will be performed

### *Detailed Operations*

1. Select one or more watersheds of interest using the Select Feature tool. Watersheds can be selected from BASINS View or the targeting view generated by a *TARGET* analysis, as shown in Screen 6.2.1. In BASINS View the Cataloging Unit Boundary theme must be active and visible to select a watershed. The Average Monitoring Value theme must be active and visible if selecting the watershed from the generated targeting views.

Tip: *ASSESS* can be run by selecting one or more watersheds within BASINS view, or the Water Quality or Permitted Discharges views generated using *TARGET*.

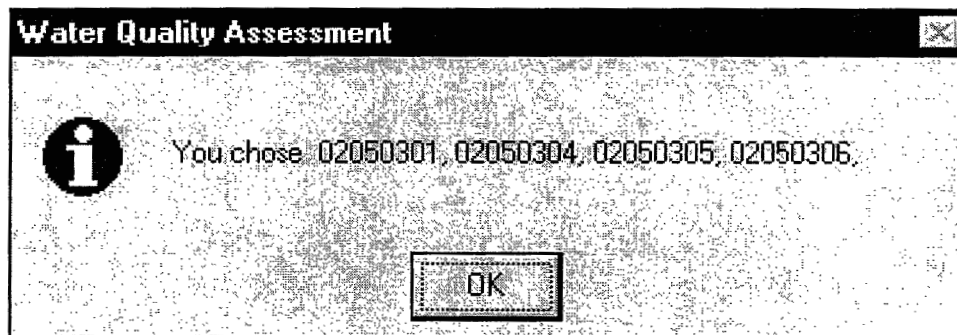


Screen 6.2.1

2. Pull down the *ASSESS* menu and select either Water Quality or Permitted Discharges (Screen 6.2.1).

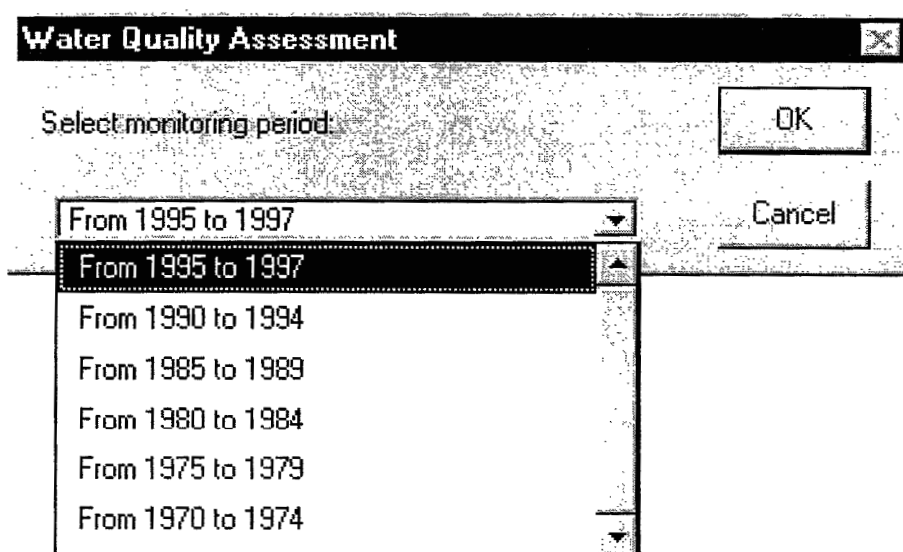
The remaining *ASSESS* steps and associated screens are similar for both Water Quality and Permitted Discharges. The following examples correspond to an *ASSESS* session using the Water Quality option.

3. The system identifies which cataloging units are selected and prompts you for confirmation (Screen 6.2.2).



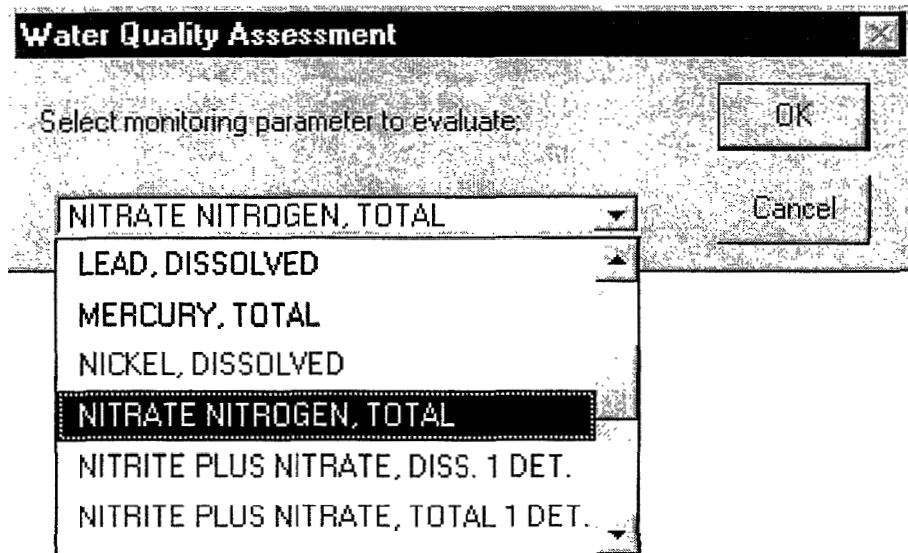
Screen 6.2.2

4. Select a monitoring time period to use for this session (Screen 6.2.3). Note that water quality statistical summaries are provided for 5-year time periods spanning the years 1970 to 1997; the 1995 to 1997 time period includes only 3 years of data. Descriptive statistics (mean; 15th, 25th, 50th, 75th, and 85th percentiles, as well as the number of water quality observations and standard deviation ) are provided for each time period and include summary data for 50 physical and chemical-related parameters. Refer to Appendix A for additional information on the water quality monitoring and permitted discharge data included in BASINS.



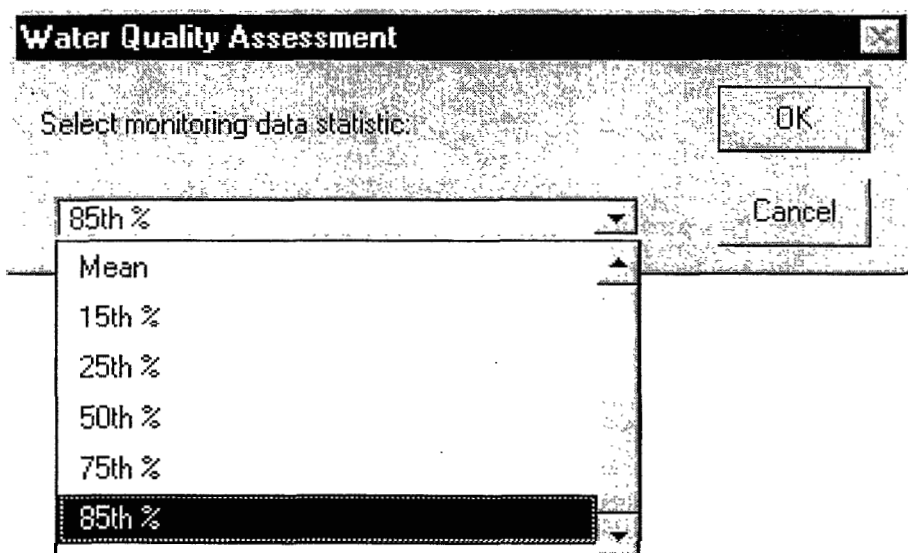
Screen 6.2.3

5. Select a parameter to evaluate (Screen 6.2.4).



Screen 6.2.4

6. Select a water quality summary statistic to use for *ASSESS* analysis (Screen 6.2.5).



Screen 6.2.5

7. The *ASSESS* session ends by generating two output windows that summarize the results (Screen 6.2.6):
- A map with water quality stations ranked according to the average monitoring value for the selected time period, selected water quality parameter, and corresponding statistical summary data.
  - A bar chart displaying the distribution of the stations based on the monitoring value

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Tip: Use overlays of other BASINS data layers (e.g., land use, Permit Compliance System) to establish a preliminary relationship between in-stream water quality conditions and other upstream sources.

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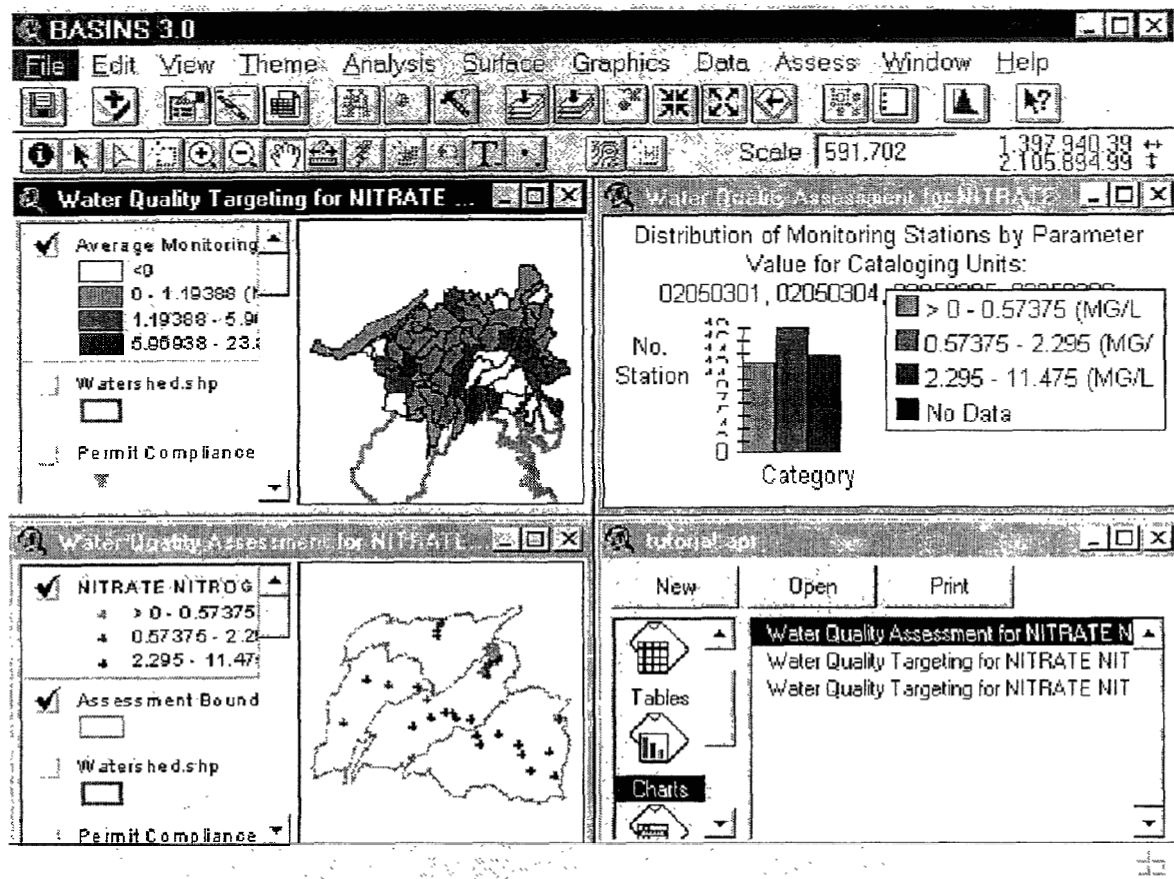
---

Tip: You can repeat this analysis iteratively using different monitoring time periods and parameters. Through this iterative analysis, you can establish the changes in a given parameter over time (e.g., compare the 1995-1997 water quality parameter values at a given station to those of 1970-1974).

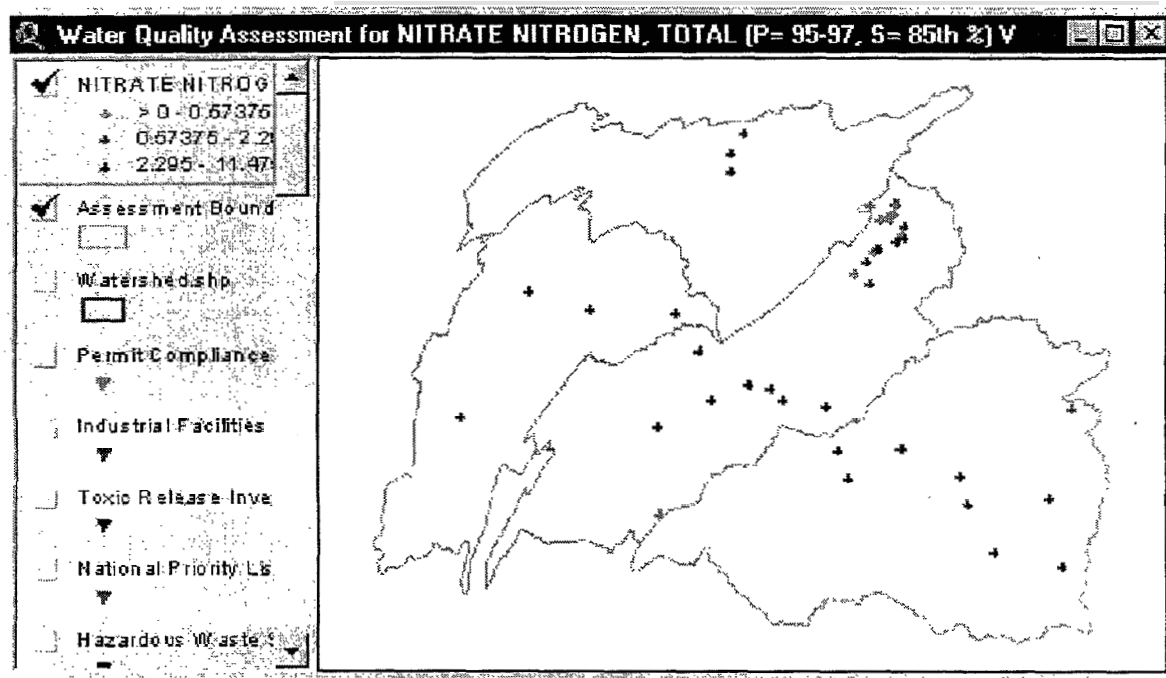
---

8. Use the ArcView Identify tool to examine data for selected stations. Screen 6.2.7 shows an expanded view of the station distribution map and the information table for a selected station containing the station reference, concentration value, and parameter measurement unit.





Screen 6.2.6



Screen 6.2.7

### TUTORIAL:

In the water quality targeting view generated with *TARGET*, select cataloging units 02050301, 02050304, 02050305, and 02050306. These cataloging units can be identified by activating the attributes table for the Average Monitoring Value theme and querying the table on the "Cu" field. Refer to ArcView HELP files for additional information on how to query an attributes table.

- Select Water Quality from the *ASSESS* pull-down menu (Screen 6.2.1)
- Confirm that the appropriate cataloging units were selected (Screen 6.2.2).
- Select the 1995-1997 time period as the period for the analysis (Screen 6.2.3).
- Select "Nitrate Nitrogen, Total" as the parameter of concern (Screen 6.2.4).
- Select 85th percentiles for the statistical summary data to be used for the analysis (Screen 6.2.5).

## 6.3 Data Mining

### *Purpose*

*Data Mining* builds dynamic links between the map interface and related data tables to allow users to retrieve and visualize (1) water quality stations and parameter data, (2) permitted facility locations and pollutant loading discharge data, and (3) bacteria stations and corresponding parameter values.

### *Application*

*Data Mining* is a tool that allows the user to retrieve and visualize BASINS water quality and point source loading data using a dynamic linkage between various related data sets. It has several technical applications, including the following:

- When used in conjunction with *TARGET* and *ASSESS*, it allows examination of impaired stream reaches and the geographical extent of potential water quality problems.
- It provides station-level statistical summaries of water quality condition for six time periods (1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1994, and 1995-1997). Changes in water quality condition as reflected in the statistical summaries are indicative of potential trends.
- When used in combination with other data layers, including upstream land use distribution and point source location, it provides a powerful tool for examining potential pollution sources and causes.
- Because it establishes a dynamic link between station locations and their corresponding loading or concentrations for all parameters monitored, it can be used to support various analyses of monitoring programs; assess the availability of monitoring data; and identify data gaps in terms of geographic station coverage, monitoring periods, and monitoring parameters.

The unique relational process established by *Data Mining* provides an integrated approach to GIS and regional data management. It brings environmental data closer to watershed and water quality analysts and allows for a detailed analysis at the site-specific level.

### **Before you Get Started**

First, verify that the “Target, Assess, and Data Mining” extension is active in your BASINS project by typing Ctrl+B from the BASINS view and selecting the **Assess** item from the **Extension Categories** dropdown list. The “Target, Assess, and Data Mining” entry in the **Basins Extensions** list should be visible and selected. If the “Target, Assess, and Data Mining” is not selected (checked), click on it to select it.

### *Key Procedures*

- Activate appropriate theme
- Activate Data Mining Feature tool button

- Use mouse to select stations or facility locations
- Select a data point or record on the resulting map or tables to review data for a given station or facility

#### *Detailed Operations*

1. Activate the Water Quality Station, Bacteria Station, or Permit Compliance System theme by clicking on the theme name. Check the box next to the selected theme for display on the BASINS view.

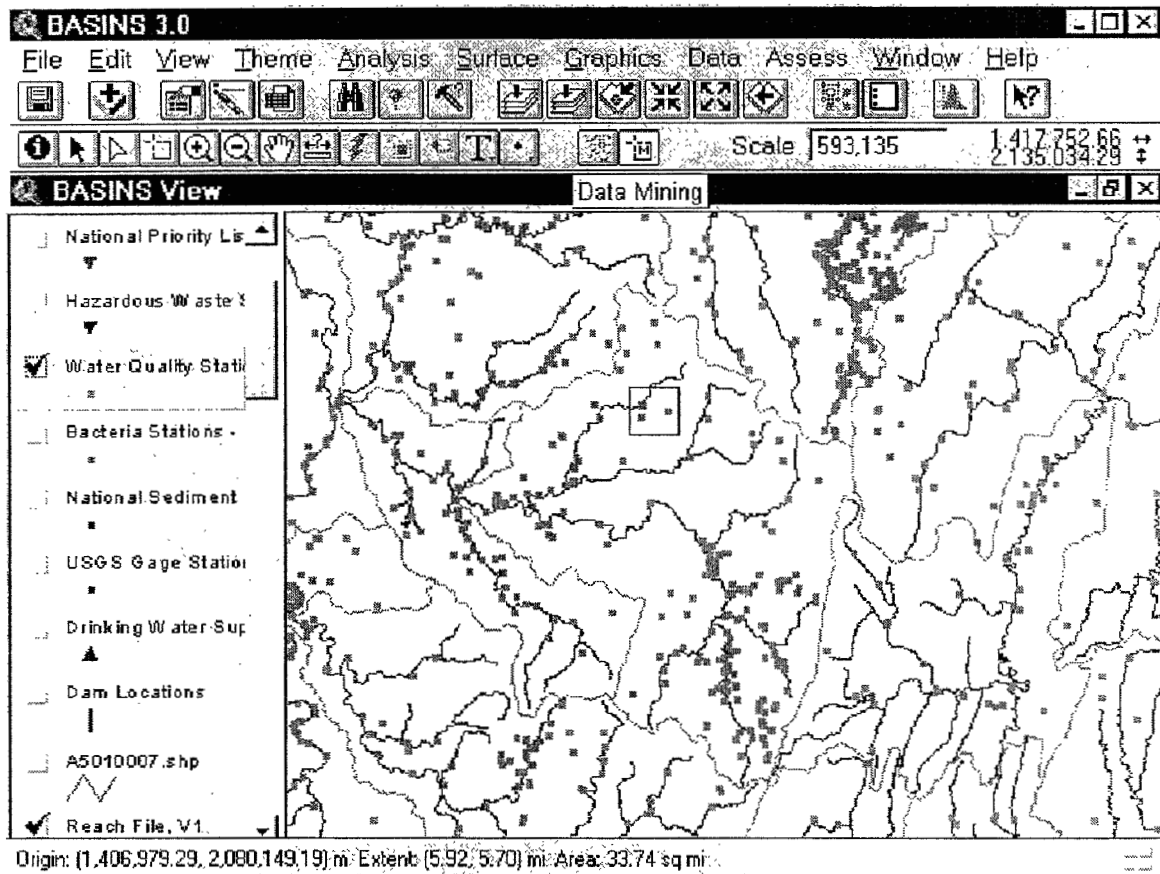
The remaining steps are the same for water quality, bacteria, or PCS data. The following example corresponds to a *Data Mining* session using the Water Quality Station theme.

2. Using the Zoom In tool, zoom to a scale suitable for selecting the desired water quality stations.
3. Activate the *Data Mining* Feature tool button.
4. Select one or more stations, dragging a box around the stations/area of interest (Screen 6.3.1).

---

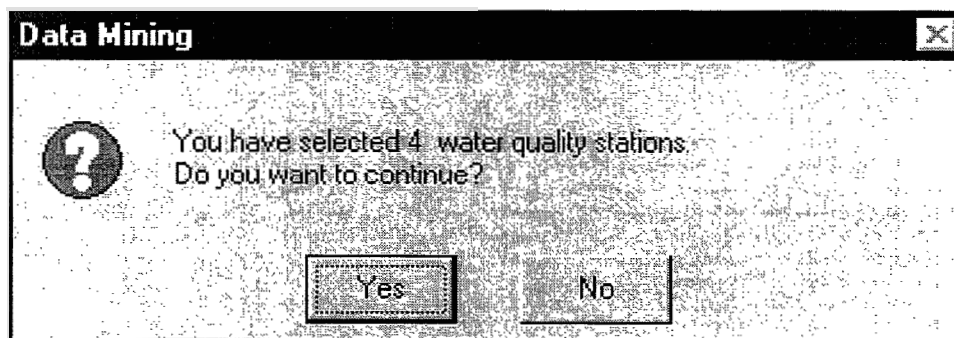
**Tip:** Although *Data Mining* can operate on an unlimited number of monitoring stations, it is best to limit the selected stations to a reasonable number to maximize the functionality of the tool.

---



Screen 6.3.1

The system determines the number of stations selected and prompts you for confirmation (Screen 6.3.2). Click *Yes* to continue.



Screen 6.3.2

5. Upon confirmation, *Data Mining* builds the appropriate relational data tables and corresponding *Data Mining* map (Screen 6.3.3). The following tables and map will be linked:

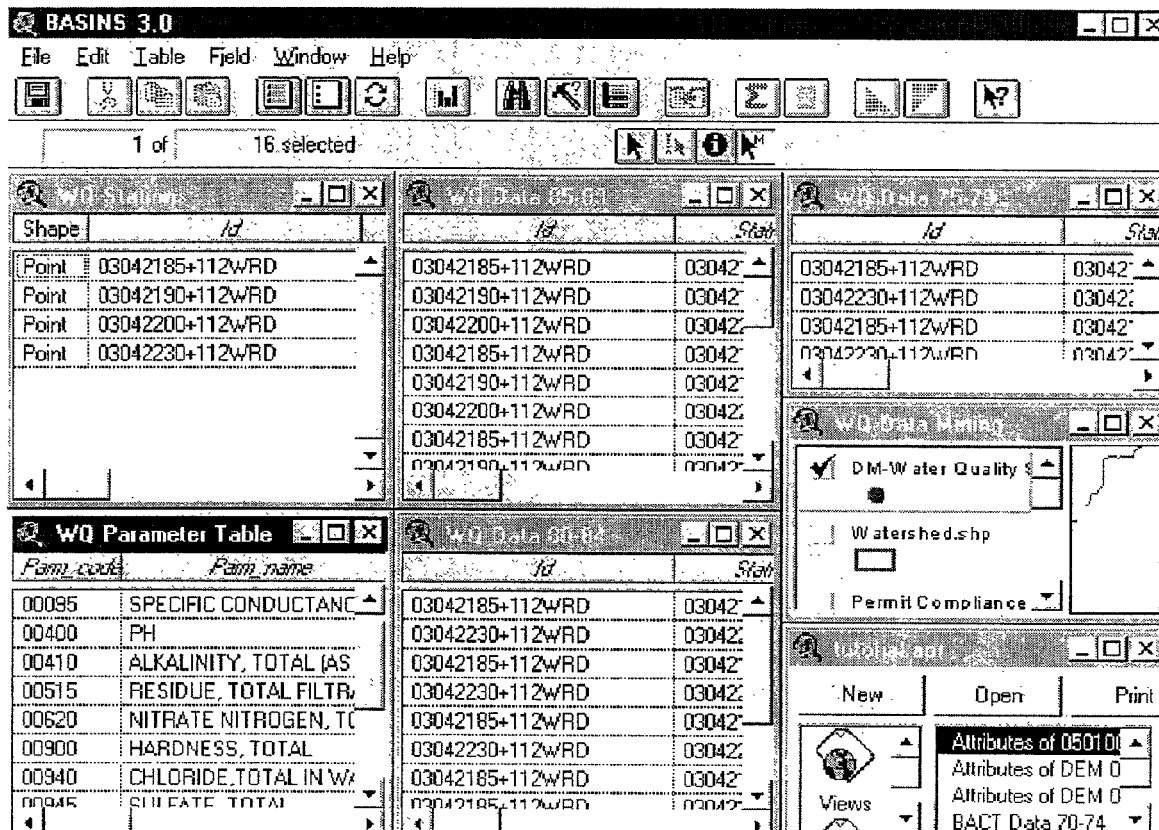
- Water Quality Station Table
- Water Quality Parameter Table
- Water Quality Data Tables (one table for each statistical summary table).
- Water Quality Data Mining View

A *Data Mining* analysis of bacteria stations will generate a similar set of tables with bacteria data. PCS *Data Mining* analysis will generate up to six permitted discharges data tables for the years 1991 through 1996 that include annual loading rates. Refer to Appendix A for additional information on the data products included in BASINS.

---

Tip: Only the data tables that contain data for the selected station(s) or facilities will be displayed. For example, if water quality data are available for only 1975 to 1989 for the selected station(s), only three water quality data tables will be displayed in the *Data Mining* results (1975-1979, 1980-1984, and 1985-1989).

---



Screen 6.3.3

- Close all the windows except the project APR view to exit *Data Mining*.

**Tip:** Data tables and maps generated by *Data Mining* will be overwritten every time this function is run; therefore, the results will not be permanently saved when the project is saved.

---

**TUTORIAL:**

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Activate the Water Quality Station theme by clicking on the theme name.

Check the box next to the theme name to display the theme on the map.

Select the following stations using the *Data Mining* Feature tool 03042185, 03042190, 03042230, and 03042200 (Screen 6.3.1). When prompted, confirm that the stations are selected (Screen 6.3.2).

Once the *Data Mining* tables and maps have been generated, click on the Water Quality Parameter Table to activate it. All subsequent linkages will be based on water quality parameters.

Click on "Alkalinity, Total (as mg/l CaCO<sub>3</sub>)" to select this parameter. Note that stations that have measured alkalinity data are highlighted in the Water Quality Stations Table and in the Water Quality *Data Mining* map. Data records are also highlighted in each of the water quality data tables (Screen 6.3.3).

Click on the Water Quality Stations title box to activate it. This changes the focus from parameters to stations.

Click on a station record. Now, all of the parameters measured by this station are highlighted in the Water Quality Parameter Table, as well as in the water quality data tables. Selected stations are also highlighted on the *Data Mining* map. If you select a station on the *Data Mining* map, the data records corresponding to the selected station will be highlighted.

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